instrumental and atmospheric causes, but in a long series it can readily be verified.

*The Individual Spectrum-Lines.*

A study was also made of the individual spectrum-lines (blends) to determine whether any of them were shifted regularly during the light-period of the variable. For this purpose thirty-nine lines were selected, and for each line the residuals (O–C)—i. e. the velocity given by the line minus the mean for all the lines measured on that plate—were formed and plotted from the measures of thirty-four spectrograms of *Y Ophiuchi* arranged according to phase in the light-period. The same was done for thirty-five spectrograms of *T Vulpeculæ*. No definite trace of a shift of any of the lines was found which is progressive with the phase of the star in its light-period.

*The Variable Star Y Ophiuchi.*

Forty-four spectrograms of this variable were obtained. My measures of the first eight spectrograms showed a variable radial velocity, the total range of variation being, however, small.[1] The solution of the orbit by the method of LEHMANN-FILHÉS gave the following elliptic elements:—

$$U = 17.1207 \text{ (light-period)},$$
$$\mu = 21^\circ.026,$$
$$T = 2.6 \text{ days after light-maximum},$$
$$\omega = 209^\circ.2,$$
$$K = 8.5^{km} \text{ (single amplitude)},$$
$$e = 0.10,$$
$$V = -5.0^{km} \text{ (velocity of system)},$$
$$a \sin i = 1{,}999{,}000^{km}.$$

There is some indication of the presence of a secondary curve, with a period equal to half the light-period and a double amplitude of $2.5^{km}$, superimposed upon the elliptic curve given above. This irregularity is such an extremely small quantity for the dispersion employed that we cannot place entire confidence in its reality. It would be equivalent to obtaining a secondary curve of $0.5^{km}$ double amplitude with the three-prism Mills spectrograph. Attention is called to the fact that the light-curve shows a similar irregularity.

[1] *Publications A. S. P.*, Vol. XVIII, 66, 1906.

More prominent irregularities in velocity-curves have been observed by CAMPBELL[1] in *ζ Geminorum,* and by R. H. CURTISS in *W Sagittarii* (*l. c.*). The cause of these secondary curves is still an unsettled question. Various explanations have been offered, such as the presence of a third body; the rotation of the brighter component; a resisting medium; or the effects of tidal forces, which must necessarily be large in such close binaries. Dr. ALEXANDER W. ROBERTS has shown[2] that considerable deviations of the principal bodies from the spherical form, in the case where the size of the stars is distinctly comparable to the size of their orbits, would give rise to a secondary period in the velocity-curve equal to half the primary period. This is a very interesting and suggestive explanation, though probably not a complete one. In *W Sagittarii* the secondary period is without doubt half that of the primary, whereas in the case of *ζ Geminorum* a secondary period, equal to one third that of the primary, satisfies the observed curve better than one of half the primary period. In a complete explanation probably a number of factors must be taken into account, and in the different individual cases one or the other of these factors may become the predominant one, and thus produce differences in the period of the secondary or in other peculiarities of this class of variables. In the course of a few years, as studies of several other variables of this and related classes will become available, we may hope to be able to speak more authoritatively in regard to the characteristics that are common to all as well as the points of difference. In individual cases we may be able to pick out the predominant influences that are at work.

### *The Variable Star T Vulpeculæ.*

The variable brightness of *T Vulpeculæ* was discovered by SAWYER in 1885. The binary character of the star was announced by FROST in 1904. Three series of spectrograms, in three successive years, were obtained and each series is satisfied by the same velocity-curve. There is thus no appreciable rotation of the line of apsides nor rapid change of any of the other elements. The solution of the orbit was made by the method of LEHMANN-FILHÉS. After several trials of various

[1] *Astrophysical Journal,* Vol. XIII, 90, 1901.
[2] *Monthly Notices R. A. S.,* Vol. LXVI, 329, 1906.